Space Weather Technical Forecast

Issued on Wednesday, 31 January 2024 at 01:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further R1/R2 Radio Blackouts. Possible glance from CME and Chance of G1 Day 1 (31 Jan). Slight Chance of S1 Radiation Storms reoccurring should any significant flares occur.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is now Low, with a peak flare of C5.7 from AR3559 over the northwestern limb, peaking at 30/1739 UTC. There are currently five sunspot regions on the disc. AR3567 in the northeast appears to have increased in complexity, with a delta magnetic configuration developing. However foreshortening due to its proximity to the northeastern limb mean this analysis is currently low confidence. AR3559 (responsible for the M6.8 flare on 29 Jan) has rotated off the visible disc. Other spots on the disc have shown some growth over the past 12 hours but have remained relatively simple and quiet, with newly numbered spots AR3568 and AR3569 both developing opposite polarity trailing spots, and are now in a beta configuration.

No Earth-directed CMEs were evident in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR and ACE at L1 showed the likely influence from the fast wind of CH94/-. The solar wind was at slightly elevated to elevated levels, between around 460-520km/s. The solar wind density trace was around or slightly above average. The interplanetary magnetic field (IMF), Bt, was weak throughout, varying between 2-6nT. The north-south component, Bz, varied weakly between +4 and -5nT. The Phi angle was predominantly negative (towards the Sun). The net result of the above solar wind measures was Quiet geomagnetic activity (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was above S1 radiation levels until 30/0425 UTC. This was in response to the M6.8 flare on 29 Jan. 10MeV proton flux has been on a gradual decline ever since but remains elevated compared to background levels.

GOES16 high energy (greater than 2MeV) electron flux was at normal background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a generally steady trend. At 31/0000 UTC the 24-hour integrated fluence observation was 1.65e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Chance of further M-class flares and a Slight Chance of isolated X-class flares in the near term. This risk reducing somewhat as AR3559 further rotates around to the far side of the Sun.

Solar Wind / Geomagnetic Activity: Generally Quiet to Unsettled conditions expected in

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association with coronal hole influence initially, with a peak of likely Active intervals and a chance of G1 Minor Geomagnetic Storms on Day 1 (31 Jan) in association with the expected shock arrival from the 29/0438 UTC CME. Further Active intervals likely towards the end of the period in association with the next coronal hole influence.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1 Radiation Storm level, with only a slight chance of going above, should any significant flares occur on Day 1 (31 Jan). This risk reduces through the period back in line with raw probabilities.

The high energy electron flux (greater than 2MeV) is low confidence due to current coronal hole influence, however exceedance of Active is deemed unlikely throughout.

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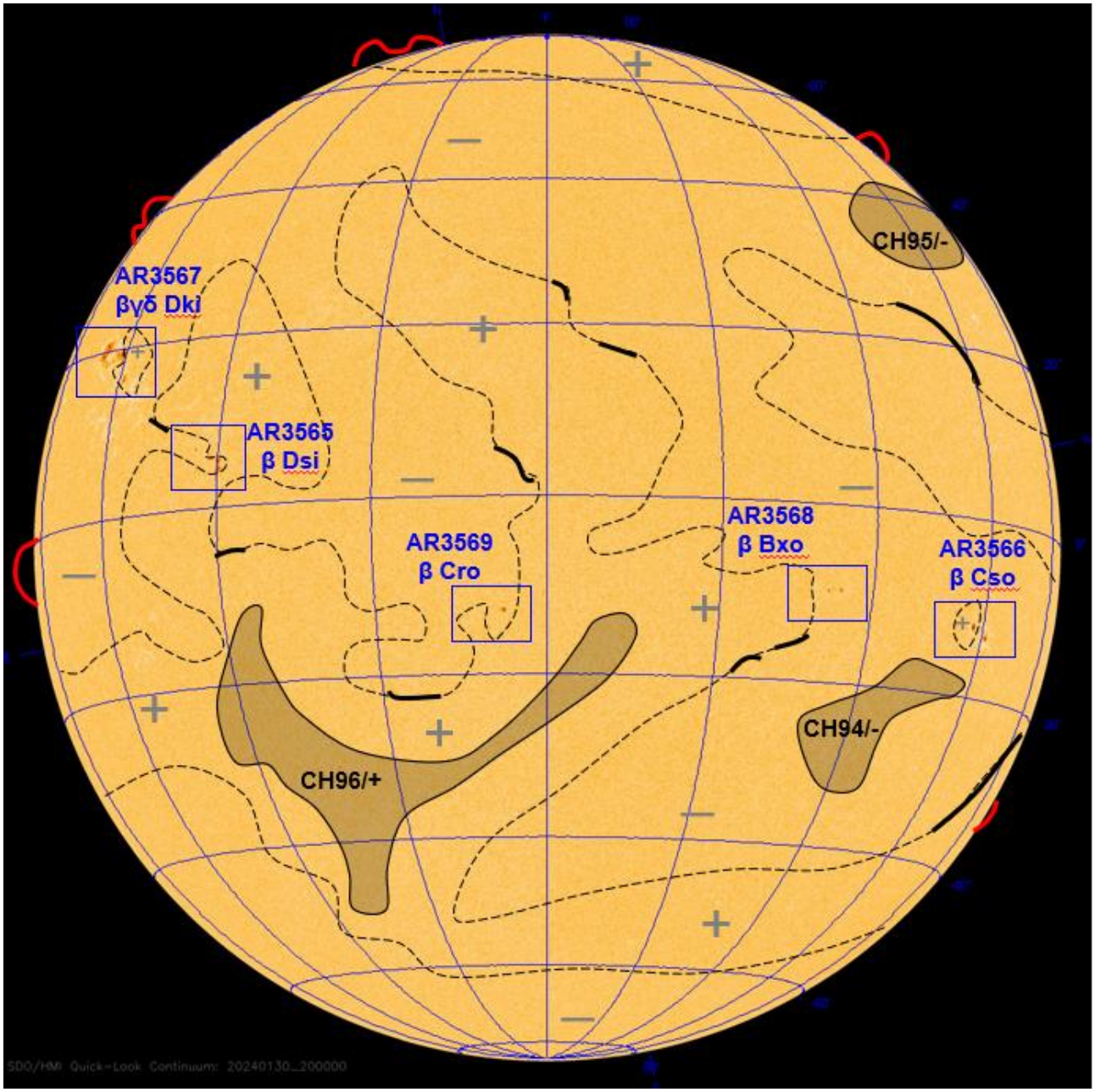
Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME that currently features in the forecast - that from the M6.8 from AR3559 at 29/0438UTC. MOSWOC Enlil modelling of this feature suggests the main bulk of the ejecta will pass well west of the Sun-Earth line early in the UTC day of Wednesday 31 January. Having said this, the shock clearly shows a partial halo component. As things stand, the CME crosses 1AU ahead of Earth early on Day 1 (31 Jan), with some ensemble members seeing a faint Earth glance from the flank later in the day. There is a Chance of G1 Minor Storm periods, probably contained within the UTC day of 31 January.

Current solar wind conditions are indicative of a minor coronal hole fast wind enhancement, with the source likely CH94. Its influence is expected to persist through Day 1 (30 Jan), with an overall fall or slight downward trend in wind speeds.

The next coronal hole enhancement is from CH96/+ in the southern hemisphere. This coronal hole has two parts, a leading portion and a trailing portion which are tenuously linked via a narrow and faint section. The arrival of the leading portion may be Day 3 (02 Feb) or perhaps more likely on Day 4 (03 Feb). Solar wind speeds may once again reach 450-500 km/s, with an associated slight chance of any geomagnetic enhancement.

All considered, generally Quiet to Unsettled conditions expected through the forecast, with likely Active intervals and a chance of G1 Minor Storm intervals on Day 1 (31 Jan) in association with the expected shock arrival from the 29/0438UTC CME. Geomagnetic activity then expected to quieten down, with the potential for further enhancements later in the period due to CH96, with Active intervals likely.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/0753	Partial	AR3559	NW limb	1150 km/s	31/0600-1800	Shock expected with bulk of ejecta expected to miss.

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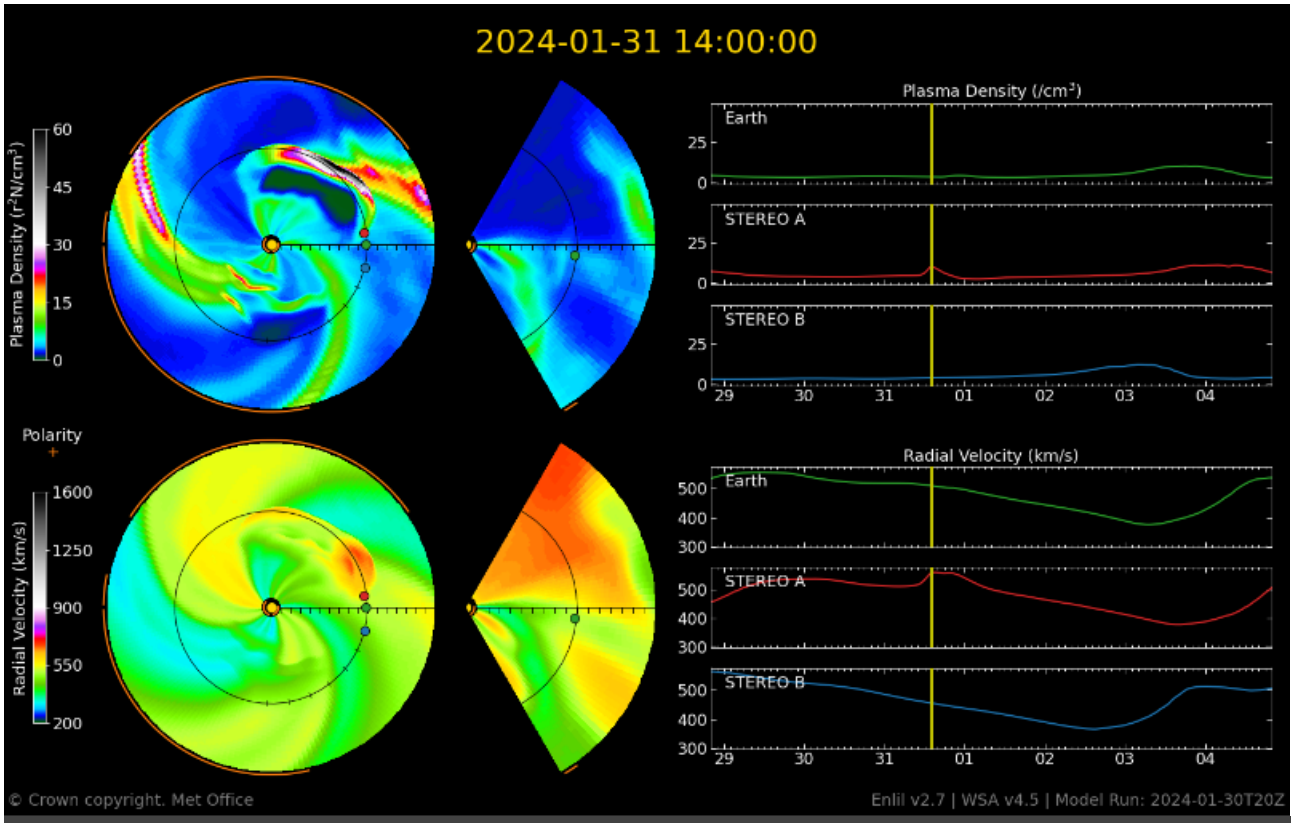
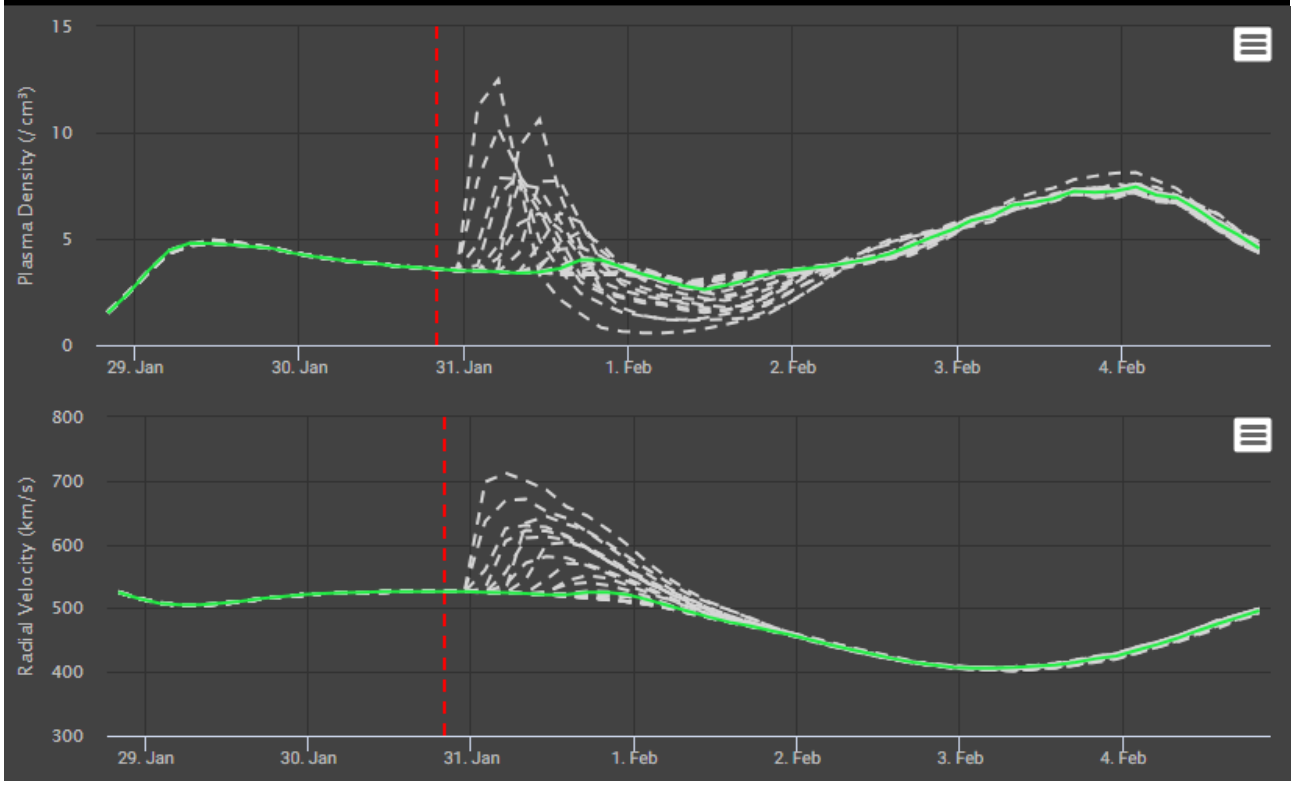
Figure 2: MOSWOC Enlil and Ensembles showing possible arrival times of CME shock





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Radio Blackouts - X-Ray Flares:
Low activity is expected with a chance of rising to Moderate, should any M class flares occur. These most probably from AR3559 from over the northwestern limb, or the AR3567 region in the northeast.

There are currently five sunspot regions on the disc. AR3567 in the northeast appears to have increased in complexity, with a delta magnetic configuration developing due to its bipolar intermediate spots being contained within one penumbra. However foreshortening due to its proximity to the northeastern limb mean this analysis is currently low confidence. AR3559 (responsible for the M6.8 flare on 29 Jan) has rotated off the visible disc, but any flares from this region over the coming hours could still affect Earth. AR3565 briefly showed a weak delta configuration, but has lost this in recent hours. The other spots on the disc have shown some growth over the past 12 hours but have remained relatively simple and quiet, with newly numbered spots AR3568 and AR3569 both developing opposite polarity trailing spots, and are now in a beta configuration.

With AR3559 further rotating around to the far side of the Sun a slight decrease in flare risk is likely, but with spots in the northeast, and magnetic looping and brightening visible in other imagery on the eastern limb, the risk is likely to remain stable through the rest of the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES16 & 18 X-ray flux

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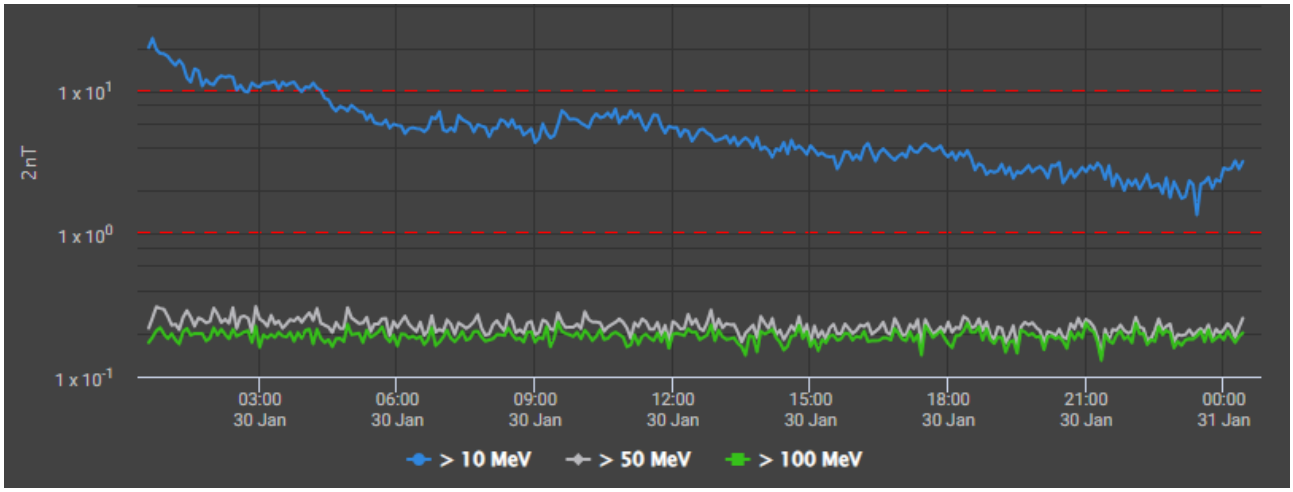
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux was initially at S2 levels following the M6.8 flare on 29 Jan from AR3559, but has since shown a steady decrease, dropping below S1 levels at 30/0430 UTC and continuing to slowly fall.

The evolution from here depends on how many further suitable flares might be produced, with it unclear as to whether AR3559 remains significantly unstable presenting a risk of further proton-producing flares given its location around the northwest limb. The risk of breaching the S1 threshold is now only a Slight Chance, should any significant flares occur. This risk reduces through the period back in line with raw probabilities, as the expected proton flux falls back to background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton flux



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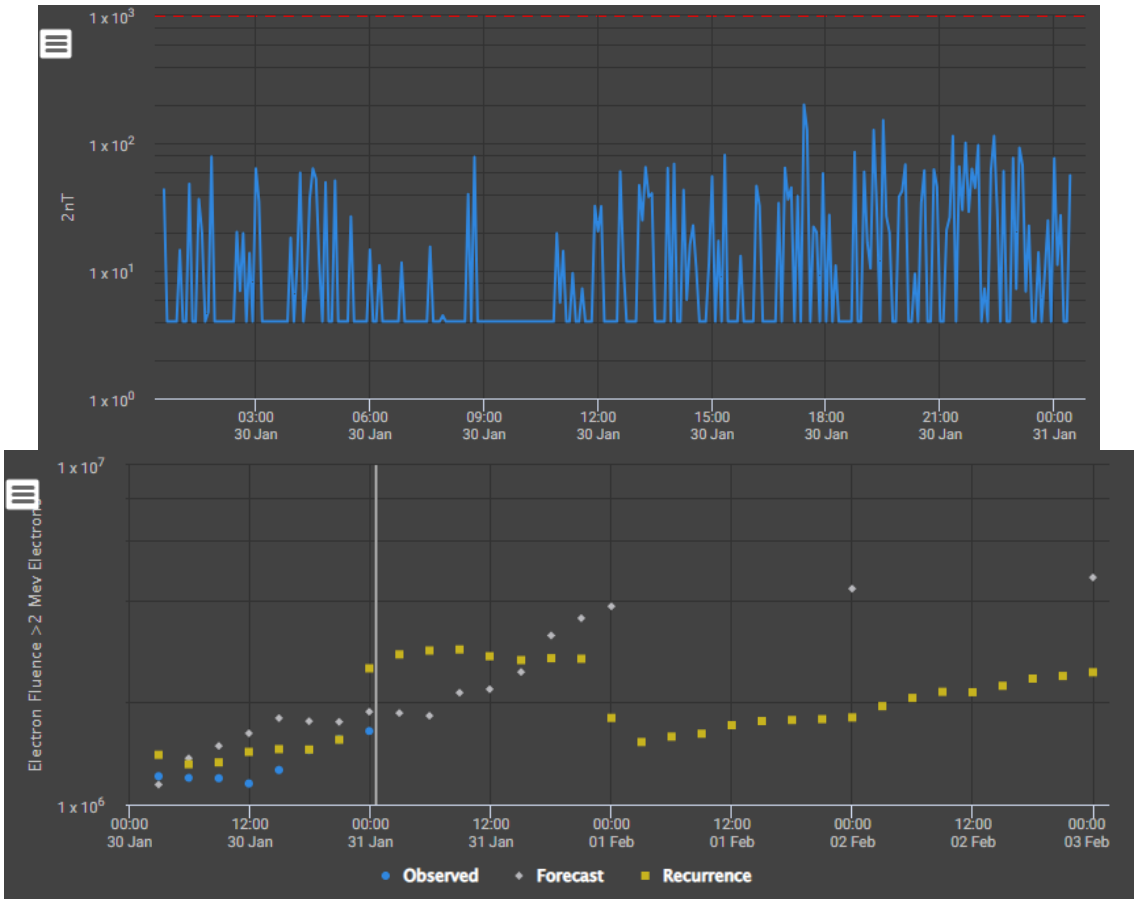
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has spent the whole of the past 27-day rotation below High levels, with an absence of significant drivers to alter this state given the expected lack of potent coronal hole fast winds. Persistence suggesting significant electron flux is unlikely following the current ongoing solar wind enhancement associated with CH94 and CH95, although the latter is at a high solar latitude for any Earth effects.

MOSWOC REFM's projections and persistence values both imply a continuation of the current quiet state, and this is the preferred forecast, although this risk increasingly slightly through the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES16 Electron flux and MOSWOC REFM



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